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ABSTRACT

This study assesses the effects of a specifically designed perceptual-motor training program on the level of perceptual-motor development, self-concept, and academic ability of kindergarten children. Forty kindergarten children were randomly assigned to one of two groups. The experimental group was exposed to a specifically designed perceptual-motor program 30 minutes daily for 5 months. The control group received a free play period for 30 minutes daily during the 5-month period. Every subject was pre- and post-tested on five variables, and data were analyzed by a multivariate analysis of covariance technique in order to assess the effects of the perceptual-motor program. Results indicate that the data tended to support the specificity of training concept. The variables showing the greatest change were the perceptual-motor tests, which measured changes on specific aspects of the training program. There appeared to be some transfer to academic abilities, but this was not pronounced enough to suggest that perceptual-motor training was of real benefit in developing academic abilities for normal kindergarten children. (Author)

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EFFECTS OF PERCEPTUAL-MOTOR TRAINING ON PRESCHOOL CHILDREN: A MULTIVARIATE APPROACH

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Effects of Perceptual-Motor Training on Preschool Children: A Multivariate Approach

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Several authors (Delacato, 1966; Frostig & Horne, 1964; Kephart, 1960) have developed and/or implemented programs of perceptual-motor training designed to influence the academic aptitude or readiness of young children. Many individual research efforts have been made to substantiate the claims for these programs. Comprehensive analysis of these research efforts by Balow (1971), Cratty (1969, 1972), Fleming (1972), Glass and Robbins (1967), Kiesius (1970, 1972), Robinson (1971), and Thomas (1974) succeeded only in delineating critical weaknesses in research design, data collection and analysis procedures and faulty or speacous interpretative statements. Although some of the theoretical assumptions of these programs appeared logical, numerous methodological errors in the individual research procedures have produced results which were inconclusive. Some of the methodological difficulties cited by the various reviewers include failure to use equated experimental and control groups, lack of precision in the experimental treatments applied, inadequate measurement of the variables involved, employment of univariate

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[1] Data were collected while the author was Associate Professor of Physical Education at Georgia Southern College.

analysis techniques, and failure to consider intervening variables such as self-concept and attention span. This study represents an attempt to overcome most of these weaknesses by attention to each of the aforementioned methodological difficulties.

The purpose of this study was to assess the effectiveness of a perceptual-motor training program specifically designed to enhance the level of perceptual-motor development, self-concept and academic readiness of kindergarten children.

Procedures

Instruments. The instruments employed in this study were selected because of their applicability in circumventing specific problems inherent in measuring selected perceptual-motor variables in young children. Successful application of four of these measures in previous research enterprises conducted by the authors encouraged the instruments' use in the study.

The Shape-O Ball Test (Chissom & Thomas 1973 ; Chissom, Thomas & Biasiotto, 1972; Chissom, Thomas & Collins, 1973; Thomas & Chissom, 1972, 1973a, 1973b; Thomas, Chissom & Biasiotto, 1972; Thomas, Chissom, & Booker, 1973) has been used extensively in previous research and is designed to measure fine eye-hand coordination, shape recognition and perceptual-motor match. Results of previous research have indicated that the Shape-O Ball Test possessed good reliability and had moderate to high validity for predicting various academic measures and other

perceptual-motor tests for preschool children. The test uses a Shape-O Ball[1] which consists of a hollow plastic sphere 6" in diameter with 10 different geometrically shaped holes in the surface of the sphere. Plastic geometric pieces that match the holes are inserted into the holes by the S as rapidly as possible. A feature of this test which distinguishes it from similar tests is its three dimentional nature. Since the ball is hollow and the pieces fall into the center leaving all the holes open, the S is faced with a task in which the probability of chance success is constant. Each S is given four trials on the test timed to the nearest sec. The sum of the four trials was used as the S's score providing measurement on a ratio scale.

The stabilometer (Singer, 1968) is a task designed to measure dynamic balance. Results of previous research with the stabilometer task for young children (Chissom, Thomas & Collins, 1973; Thomas, Chissom & Booker, 1973) indicated good reliability and moderate correlations with various academic measures. The stabilometer consisted of a board (2' x 3') mounted on a fulcrum 4½" from a wooden base. The board would tilt to either side with a maximum off balance angle of 12°. Micro-switches were placed on either side of the base so that when S went off balance to the maximum angle (12°) the microswitch was closed. The microswitches were wired through an interval timer to a running time meter which only operated during the trial period and when the micro-

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[1] The Shape-O Ball is a commercial product of Dart Industries, Inc., Tuperware, Orlando, Fla. 32802

swithces were open. This resulted in the time meter recording time on balance (TOB) during the trial. Each S was given four trials and the sum of the four trials was used as the score, again yielding data on a ratio scale. S's began each trial in an off balance position and the direction of the position was counterbalanced to right foot down, left foot down, left foot down and right foot down. A 30 sec. rest period was given between the second and third trials.

The two academic measures, Otis-Lennon Mental Ability Test and a composite teacher rating, for the study were used in most of the authors' previously cited studies. In particular two studies (Chissom & Thomas, 1971; Thomas & Chissom, 1973) comparing these measures, indicated high degrees of validity and reliability for these measurements of academic abilities. The Otis-Lennon Mental Ability Test (MAT) (1967) Primary I Level is designed to measure general mental ability or scholastic aptitude and consists of 55 items designed to be non-verbal. The test is divided into two parts. Part I contains 23 items in which the S is asked to select the different picture from a group of four pictures. In Part II (32 items) the S responds by circling the picture that corresponds to the verbal description read by the tester.

A composite teacher rating (TR) of four areas of academic ability was collected for each S from the classroom teacher. The four areas of academic ability were reading readiness, quantitative skill, verbal and listening ability. Ss were rated in each of the four areas on a scale ranging from a low of one to a high of nine. The sum of the four ratings

was used as the individual's score permitting a maximum of 36 and a minimum of four points.

Self-concept was added as a variable in this study because Fleming (1972) hypothesized self-concept as an intervening variable in studies of perceptual-motor training i.e., increased self-concept comes about as a result of the perceptual-motor training and in turn produces changes in academic ability. For this reason the final measure employed in the study was designed to assess self-concept (Parker, 1966). However, the original form of the scale was designed to be used with children at or above third-grade level. The S read a statement and responded to it on a five point Likert scale ranging from "like me" to "not like me." An adaptation of this scale was developed for the preschool Ss in this study. The original 36 items were reduced to 20 items and the five point scale was reduced to three. The format for administration involved reading the statement aloud to the S and having him respond on a scale of "like me," "unsure," "not like me." The alterations of the scale were the result of a pilot test with preschool children.

Subjects. Previously conducted research (Chissom, 1971; Thomas & Chissom, 1972) has indicated that the relationship between the perceptual-motor and cognitive domains was highest for early elementary school children (kindergarten and first grade) but decreased as age increased. For this reason kindergarten Ss were selected for use in this study. These Ss were 40 kindergarten children from the Marvin Pittman School which serves as the laboratory school for Georgia Southern College. The

population of this school is designed to reflect the socioeconomic and racial balance of the community. The average age of the Ss at the beginning of the study was 68.3 months (SD = 3.79). There were 20 males, 19 females, 9 black and 30 white children in the sample.

Design of the Study. The 40 kindergarten Ss were randomly assigned to two sections of 20 Ss each with one group designated as experimental and the other serving as control. Because one S from the control group was lost, one S from the experimental group was randomly eliminated.[1] The groups were taught by two different teachers who applied the same predetermined kindergarten program for both classes. The differentiating factor in the programs was a 30 minute perceptual-motor program administered daily to the experimental group by a trained experimenter while the control group received a 30 minute free play period supervised by the classroom teacher. This program was conducted for 30 minutes daily during a five month period from January to May 1973.

The experimental program was designed to improve specific perceptual-motor skills previously identified as correlating significantly with academic abilities. These perceptual-motor skills were fine eye-hand coordination, dynamic balance, shape recognition and perceptual-motor match. Examples of the activities used and the respective perceptual-motor skills they were intended to affect are: (1) Block stacking, puzzles and manipulative table activities for fine eyehand coordination; (2) balance boards, beams and string walking for dynamic balance; (3) shape sorting

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[1] The multivariate analysis of covariance program required equal group Ns.

and paper and pencil tracing task for shape recognition, and (4) puzzles and shape matching for perceptual-motor match. Activities were identified and planned in advance for the entire program and all children were exposed to all types of developmental activities. This was accomplished through the use of a "station plan" with a teaching aide at each station. Ss were encouraged to spend extra time (within the 30 minute treatment period) at stations with activities in which they demonstrated deficiencies.

All Ss were pre- and post-tested on all five dependent variables: perceptual-motor skills--Shape-O Ball Test and the stabilometer, academic ability--Otis-Lennon MAT and TR, and the self-concept scale. The perceptual-motor tests and the self-concept scale were administered individually by the trained experimenter who conducted the training program. The Otis-Lennon MAT was administered according to directions in the manual with a student to tester ratio of four to one. The TR was completed by the classroom teacher who was not aware of other test results.

A multivariate analysis of covariance (Cooley & Lohnes, 1971; Dixon, 1972) with the five pre-tests serving as multiple covariates and the five post-tests serving as multiple dependent variables was selected as the most appropriate analysis technique. The primary advantage of this technique is to provide for simultaneous analysis of several dependent variables which are not necessarily independent of each other. This technique removes shared variance among dependent variables allowing investigation of the unique effects of the treatment on these variables. The covariance adjustment was used because when N is not large, random assignment may fail to equate the groups.

Results and Discussion

Reliabilities for the measures were computed for the total group on the pre-test and within experimental and control groups for the post-tests. The Shape-O Ball Test reliability was estimated by intraclass correlation (Safrit, 1973) and adjusted for test length. Reliabilities ranged from a low of .86 to a high of .92. The same method was employed to obtain a reliability estimate for the stabilometer and the reliabilities ranged from a low of .85 to a high of .90. The Otis-Lennon MAT reliability estimates were obtained by the split-half odd-even method and ajusted by the Spearman-Brown formula (range = .88 to .91). The TR reliability was estimated by Cronbach's alpha and ranged from .94 to .97. The self-concept scale reliability was always above .98 as estimated by the odd-even split half method and adjusted by the Spearman Brown formula (This result should be viewed as inflated due to a lack of variability in the measure).

The pre-test, post-test and adjusted post-test means are reported for each of the five variables by groups in Table 1. The multivariate analysis of covariance test indicated that the two groups were significantly different ($F = 3.56$; $df = 5, 27$; $p < .05$) when all five dependent variables were assessed simultaneously and adjusted for initial differences. By observing the adjusted post-test means in which four of the five dependent variables favored the experimental group (Shape-O Ball Test is inverted because of the time score) it may be concluded that the perceptual-motor training program had overall significant effects. After observing this overall trend, a subsequent discriminant analysis

(Dixon, 1972) was performed in order to determine the relative contributions of each of the five measures to differences between the two groups. Because the groups were slightly dissimilar on the initial scores, and because of scaling differences between the dependent variables, a difference score (pre to post) was computed for each individual on each of the five variables. These difference scores were converted to z scores to provide equivalent scales for comparing the weights of the discriminant function.

Comparison of the weights indicated that the stabilometer, Shape-O Ball Test and Otis-Lennon MAT made the greatest contributions to group differences. The fact that the groups were significantly separated on this profile of variables was further substantiated by the significant Mahalanobis D^2 of 19.30. Using the discriminant function, 74% (14 of 19) of the Ss in the experimental group and 84% (16 of 19) of Ss in the control group were correctly placed.

A separate univariate analysis of covariance was performed for each of the five dependent variables using its pre-test as a covariate. Significant differences occurred between the two groups for the stabilometer and self-concept measures. This analysis further emphasized the need for a multivariate approach because of the seemingly significant contribution to differences between the groups on the self concept measure. In the multivariate analysis, the self-concept measure did not make a unique contribution to differences between groups because variance accounted for by this measure was also accounted for in the two perceptual-motor tests and the Otis-Lennon MAT.

Results of this study generally supported the specificity of training concept. The experimental perceptual-motor program was designed to improve specific aspects of perceptual-motor function which related to academic abilities. That these funtions were improved was supported by the fact that the perceptual-motor measures received the heaviest weights in the discriminant function. The relatively heavy weight assigned to the Otis - Lennon MAT suggest that the program made a slight contribution to differences in academic abilities as well. The lack of support for self-concept as an intervening variable may be due to lack of variability on this particular measure rather than the failure of self-concept to be an important contributor to advantages gained as a result of a perceptual-motor training program. The results indicated little potential usefulness for this particular self-concept measure for preschool children. A more productive approach might be the use of newly developed self-concept measures involving card sorting of pictures that yields a self-concept score for this age group.

In conclusion, this study indicated that a program of perceptual-motor training was useful for developing specific perceptual-motor skills. However, in order to develop academic readiness, a broader program, individualized to specific weakness, and incorporating activities designed to develop specific components of academic readiness seems to be indicated.

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Table 1. Means, Univariate and Multivariate Analysis of Covariance, and Discriminant Function for the Two Groups (N_E = 19, N_C = 19)

Variables	Groups	Pre Test	Post Test	Adjusted Post-Test	Univariate ANOCV (df = 1,35)
1. Shape-O Ball Test	E	418.00	305.47	287.26	1.08
	C	347.74	290.63	308.85	
2. Stabilometer (Dynamic Balance)	E	52.38	62.52	63.64	6.20[b]
	C	55.93	57.30	56.17	
3. Self-Concept	E	56.79	58.95	58.87	7.46[b]
	C	55.53	56.53	56.61	
4. Otis - Lennon MAT	E	3 .39	38.63	40.06	0.64
	C	34.68	40.05	38.63	
5. Teacher Rating	E	20.11	22.11	22.39	0.64
	C	20.68	23.58	23.30	

	U-Statistic	Approximate F	df
Multivariate ANOCV	0.60	3.56[b]	5,27

Discriminant Function: Shape-O Ball Test (-.46), Stabilometer (.65), Self-Concept (.11), Otis - Lennon MAT (.38), Teacher Rating(-.05)

Mahalanobis $D^2 = 19.30^a$, df = 5

a $p < .01$
b $p < .05$